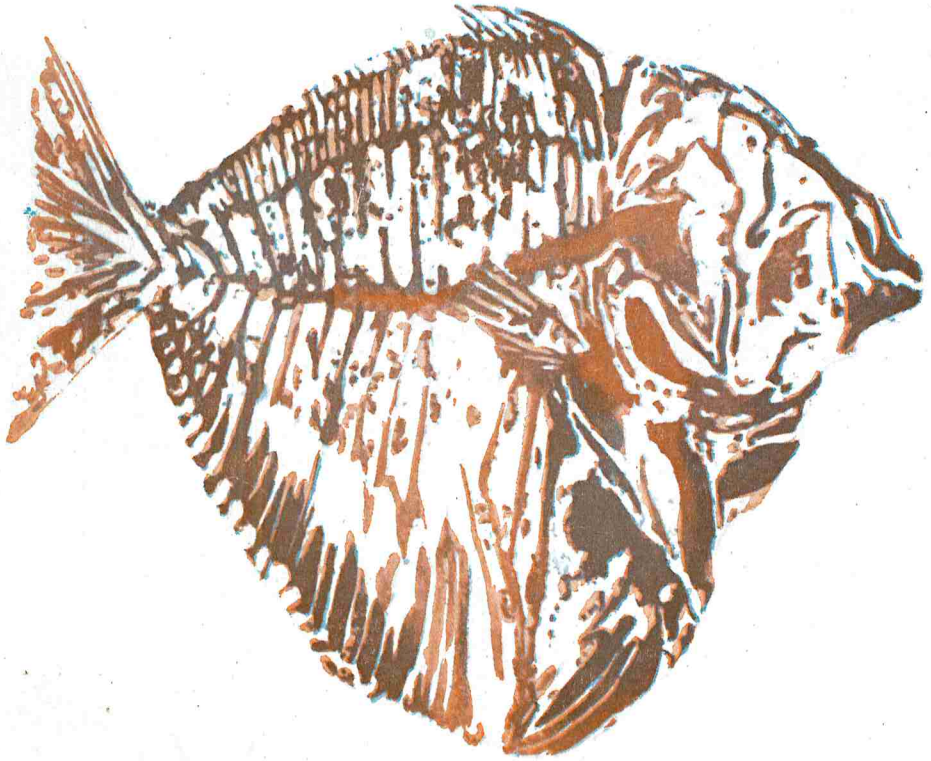
THE EARTH BEFORE MAN



A guide to the Geological Gallery Liverpool Museum

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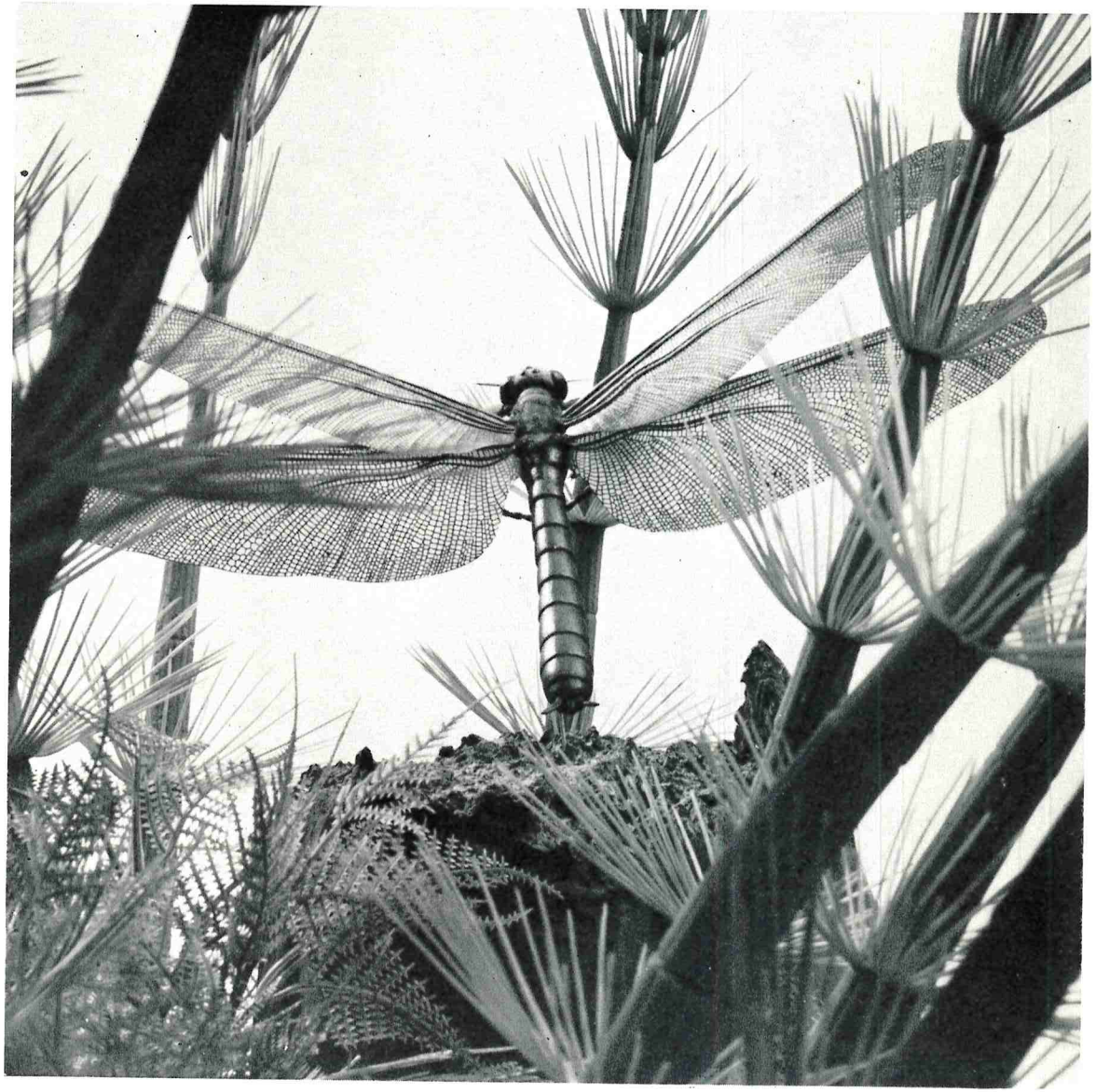
The Earth Before Man

A guide to the Geology Gallery
Liverpool Museum

Geoffrey Tresise

City of Liverpool Museums 1966

The Coal Forest dragon-fly *Meganeura* (Model).



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The key to the past

The various sciences concerned with studying the earth, and the forms of life of the past, are grouped together under the general name of Geology.

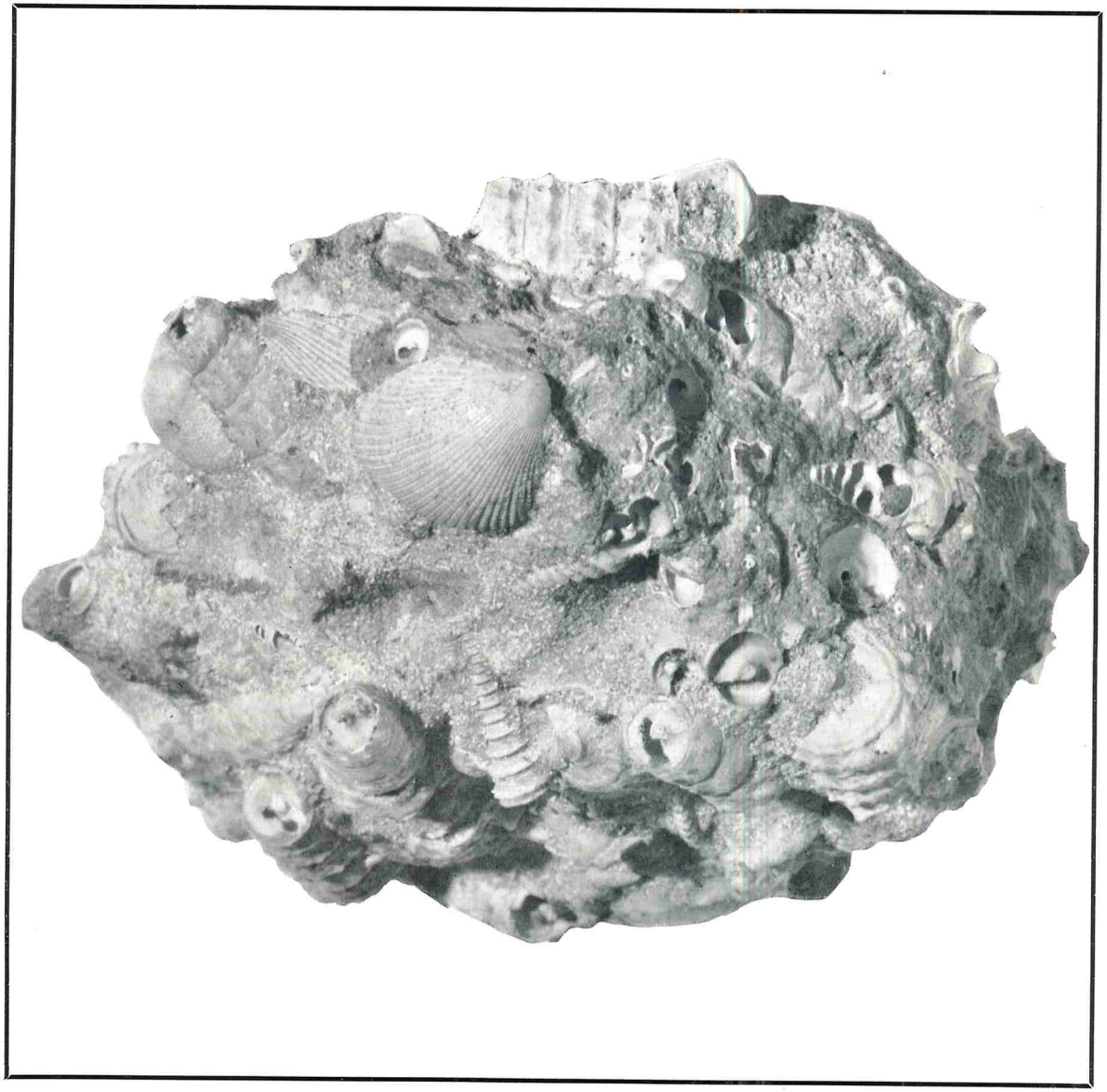
James Hutton, a Scottish doctor and one of the pioneer workers who put the subject on a scientific basis, wrote in 1785:

'The present is the key to the past.'

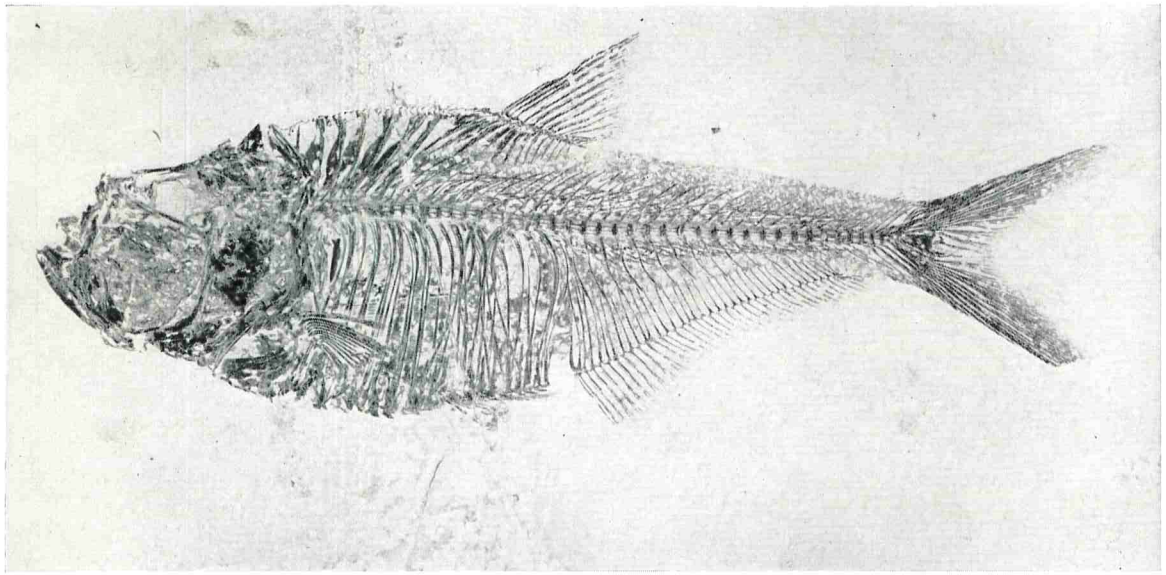
Hutton realised that at any moment in the earth's history the physical forces at work would be very like those operating at the present day: the waves of the sea would eat away the coastline; rivers would slowly erode the surface of the land, depositing the finely ground debris as sediment on reaching the sea; and particles of dust would blow from place to place with the wind. Such processes, operating over countless millenia, had slowly but surely changed the face of the globe and would continue so to change it in the future. 'We find' wrote Hutton 'no vestige of a beginning – no prospect of an end.'

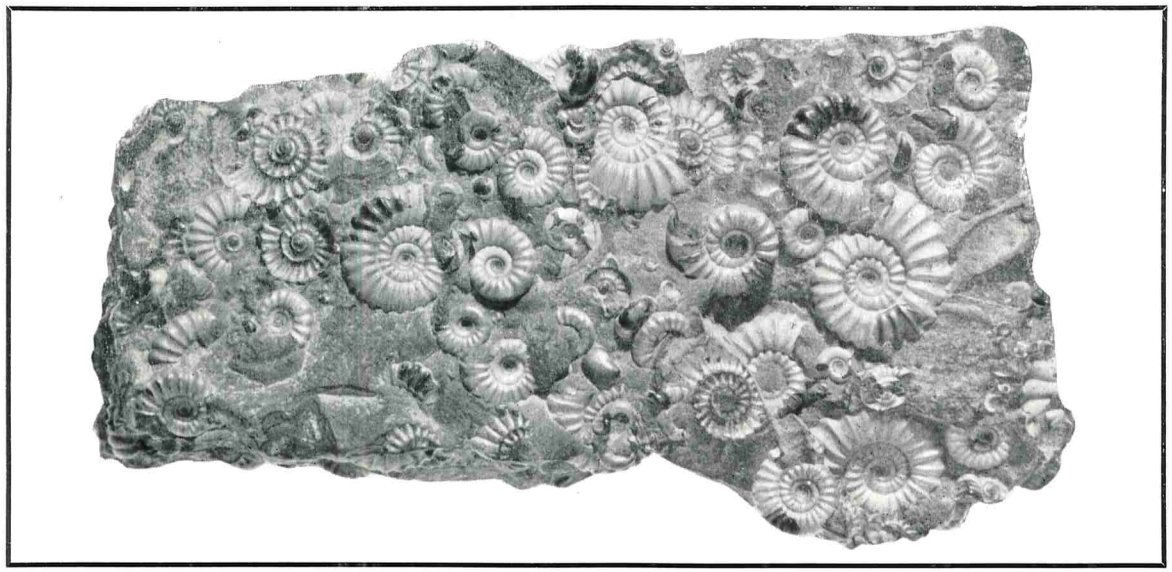
Hutton failed to realise, however, that just as the landscape changed in course of time, so did the animals and plants which inhabited the earth. Remains of earlier forms of life which survived in the form of fossils embedded in the rocks were to prove the true key to the past.

Fossil shells in limestone.



Above: Fossil Fish. Below: Ammonite Limestone.





The record of life

Fossils are the remains of ancient animals and plants preserved in beds of rock, and though some are clearly related to living species, others are of types long extinct.

Fossils of the future can be seen on any beach where dead creatures lie stranded. The majority of fossils were once marine animals whose bodies were buried in the soft muds of the sea-bed; these muds subsequently hardened into rocks which now enclose the fossil remains of the animals.

From a study of fossils much can be learned about past forms of life. Complete carcasses of frozen mammoths have been found in Siberia but normally only the hard parts of the body (the skeleton of vertebrate animals and the shells of invertebrates) survive in fossil form, the fleshy parts having decomposed soon after death.

More rarely 'trace-fossils' such as worm-casts and excretal droppings are preserved, while in the case of *Chirotherium* discussed later, only the footprints survive as proof of the animal's former existence.

Many authors (among them Herodotus, writing about 450 B.C.) had pointed out that the presence of sea-shells in rocks many miles inland must mean that the sea had once extended far beyond its present limits. The full significance of this was, however, only realised in the closing years of the Eighteenth Century, as a result of the work of a surveyor and civil engineer named William Smith.

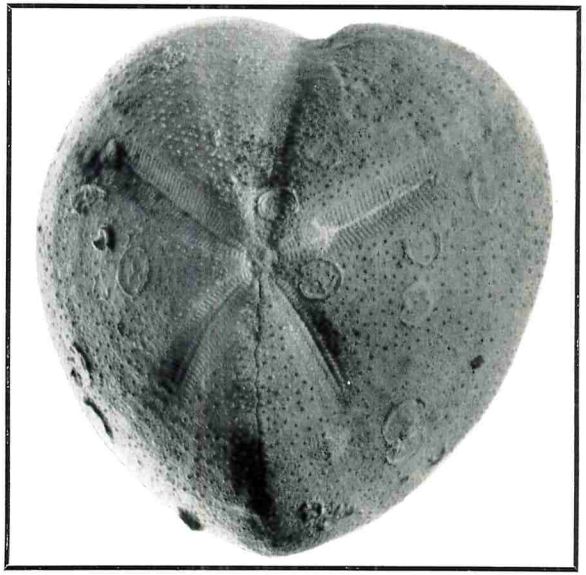
The Father of English Geology

Left: William Smith, aged 69. Right: Two of Smith's key fossils, an Ammonite (above) and an Echinoid.

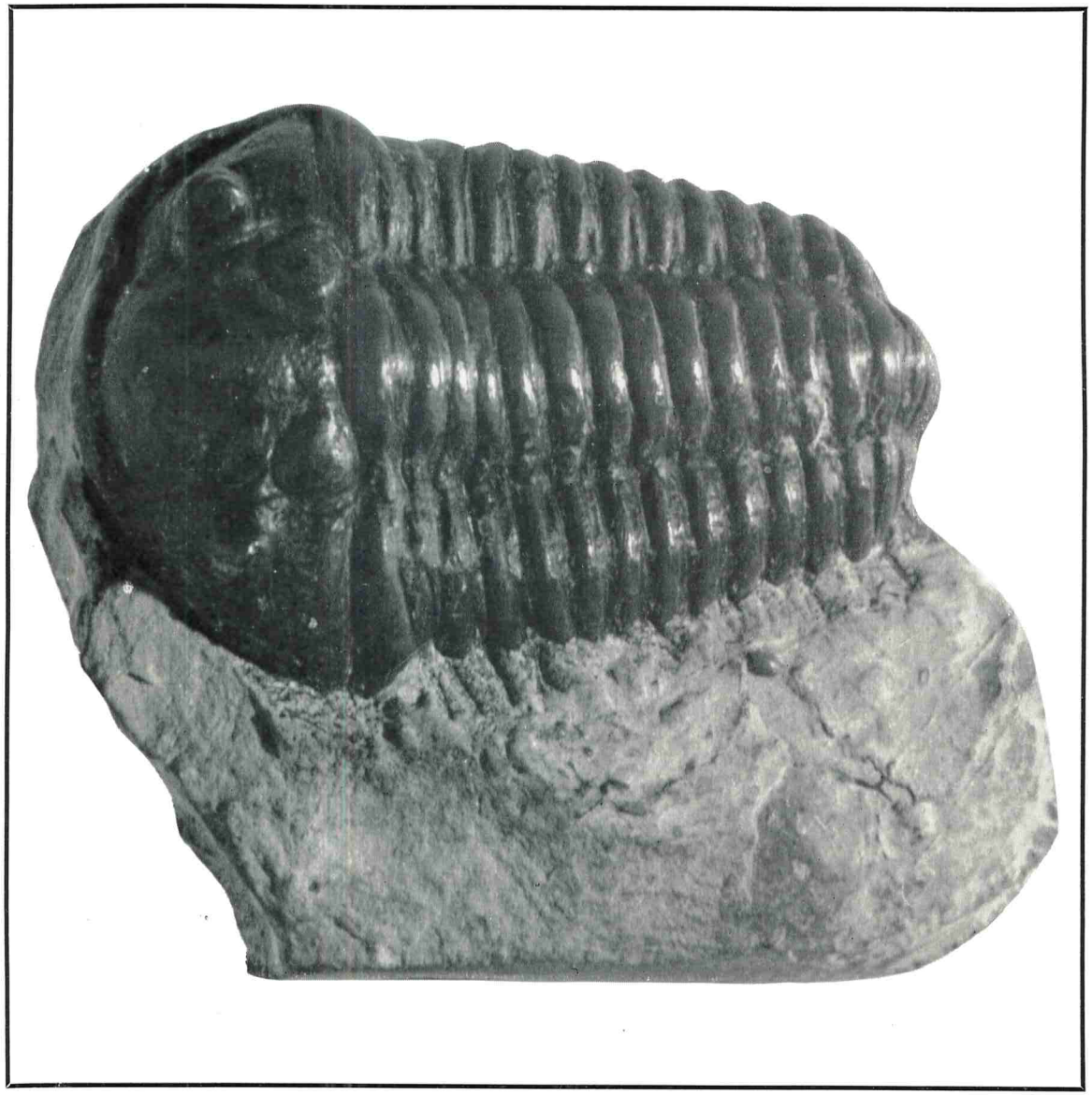
William Smith (1769-1838) was a civil engineer who specialised in the construction of canals. On the sites of his excavations he noticed bands of shells within the rocks and realised that these represented an ancient sea-floor on which the creatures had lived and died. It followed that the rocks themselves must have been laid down in layers on the bed of the sea. Smith therefore deduced that the layers underneath must have formed before those lying on top, and hence that each bed was older than those above it, but younger than those below it.

Smith began to collect the fossils noting as he did so the layers in which they were found. In this way he made the important discovery that though some fossils ranged from one group of beds to another, certain fossils were always confined to one particular bed. He realised too that the sequence in which the fossils appeared was always the same, the fossils in one bed of rock enabling him to predict those to be found in the beds above and below. It followed that beds containing the same fossils must be of the same age, and could be 'dated' by the fossils found in them.

Using the fossils he found, Smith was able to map the rock strata across the country and in 1815 he published the first geological map of England and Wales. He was later to be honoured by the Geological Society of London whose President, presenting him with the Society's medal in 1831, described him as 'The Father of English Geology'. Time has fully justified this description since the methods William Smith employed and the principles he formulated have formed the basis of geological studies ever since.



Trilobite.



Dating the past

With William Smith's discoveries providing the key geologists needed to determine the succession of life in the past, it soon became obvious that the earth's history was far longer and more complex than had previously been realised. Creation, which a Seventeenth Century Archbishop of Ireland calculated to have taken place on Sunday, October 23rd, 4004 B.C., was gradually pushed further and further back into the remote past.

It is only during the last twenty years, however, that reliable methods of measuring geological time have been brought into use. Since certain rocks contain radioactive elements (isotopes of Uranium, Potassium and Rubidium) which are unstable and decompose at a known rate, it is possible to calculate the interval of time that has elapsed since the rock was formed. From hundreds of such measurements, taken at different horizons in the geological succession, an accurate time-scale is now being built up.

Because no rocks from the formative period survive, it is still impossible to determine the age of the earth itself. 4,000-5,000 million years would seem to be a reasonable estimate, however. The earliest traces of life, probably blue-green algae, are found in limestones from Southern Rhodesia which are more than 2,800 million years old.

In these very ancient rocks traces of life are extremely rare and fossils did not become common until some animals developed hard shells to protect their bodies. Among the first of these were the Trilobites which appeared at the beginning of the Cambrian period 600 million years ago, and since then the fossil record has been unbroken.

Geological Time-Scale IN MILLIONS OF YEARS

		Duration of period	Time-lapse since beginning of period
CAENOZOIC ERA *New life*	PLEISTOCENE	2	2
	PLIOCENE	9	11
	MIOCENE	14	25
	OLIGOCENE	15	40
	EOCENE	20	60
	PALEOCENE	10	70
MESOZOIC ERA *Middle life*	CRETACEOUS	65	135
	JURASSIC	45	180
	TRIASSIC	45	225
PALAEOZOIC ERA *Old life*	PERMIAN	45	270
	CARBONIFEROUS	80	350
	DEVONIAN	50	400
	SILURIAN	40	440
	ORDOVICIAN	60	500
	CAMBRIAN	100	600
PROTEROZOIC ERA *Early life*	UPPER PRE-CAMBRIAN		
		The first appearance of life has yet to be traced and dated	
AZOIC ERA *No life*	LOWER PRE-CAMBRIAN		

Succession of life

PLEISTOCENE	Stone-age man. Mammoths and first one-toed horses.
PLIOCENE	Man-like apes. Many present-day animals and plants.
MIOCENE	First large apes. Mammals reach peak of their development, many giant forms.
OLIGOCENE	Spread of grasses. Disappearance of primitive mammals.
EOCENE	Specialisation of mammals. Lemurs, tarsiers and primitive monkeys appear.
PALEOCENE	Mammals dominate the land. First of the primates (Tree-shrews).
CRETACEOUS	Flowering plants appear. Dinosaurs extinct by close of period. Last ammonites.
JURASSIC	First giant Dinosaurs. Flying reptiles and first birds. Ammonites reach their peak.
TRIASSIC	Appearance of Dinosaurs. First primitive mammals. Last giant amphibians. First true ammonites.
PERMIAN	Amphibians rivalled by reptiles. Last trilobites. Cycads and conifers replace primitive plants.
CARBONIFEROUS	Coal Forest swamps. 'Age of Amphibians.' First reptiles. First winged insects.
DEVONIAN	First boned fish. First lung-fish and amphibians. Spiders and wingless insects colonise the land.
SILURIAN	First plants on land. Coral reefs in shallow seas. Giant sea-scorpions in lagoons and coastal waters.
ORDOVICIAN	Primitive forms of fish. Graptolites, trilobites and brachiopods common. First corals and sea-urchins.
CAMBRIAN	'Age of Trilobites.' Primitive brachiopods, molluscs and star-fish.
UPPER PRE-CAMBRIAN	Soft-bodied animals – only a few primitive fossils.
LOWER PRE-CAMBRIAN	No fossils. Some chemical evidence of life – algae may date back 2,800 million years.

The primeval seas

The 200 million years from the beginning of the Cambrian to the close of the Silurian period comprise the Lower Palaeozoic era. Throughout this time life was wholly confined to the seas since neither plants nor animals had yet adapted themselves to life on the land. This was the heyday of the Invertebrates – the 'Animals without Backbones' which even now comprises 95% of the animal kingdom.

Trilobites were the most advanced animals to inhabit the Lower Palaeozoic seas. Their segmented bodies were covered with a hard shell which, like modern crabs, they shed periodically as they grew. Known only in fossil form, they were the first of the Arthropods – the group of 'jointed-leg' Invertebrates which today includes the crabs and lobsters, insects, spiders and scorpions.

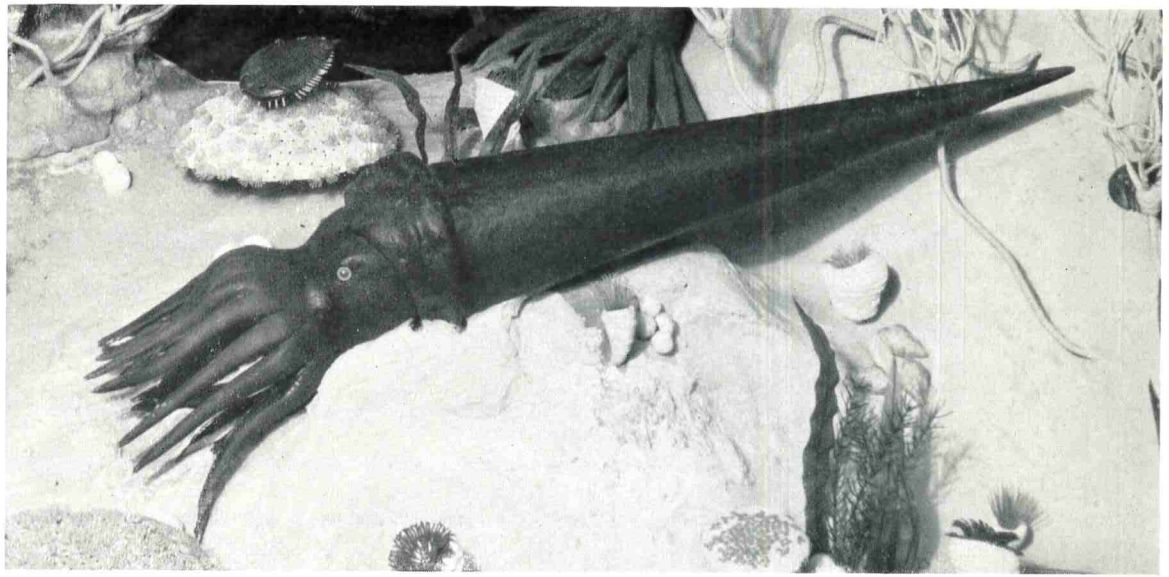
Corals were of particular importance during the Silurian period when both solitary and reef-building colonial forms were common. Their abundance in British seas at this time suggests a warmer climate than that of the present day.

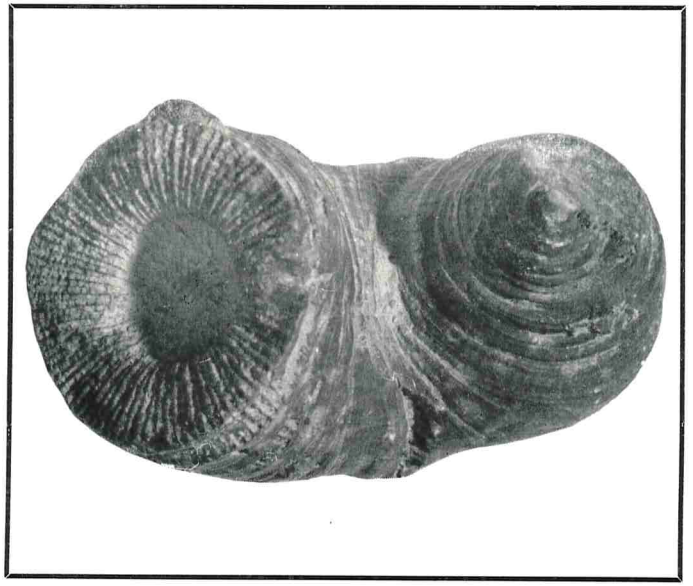
Crinoids also characterised the Silurian period. They survive as the 'sea-lilies' of modern seas but are now found only in deep waters. In appearance they resemble sea-anemones set at the top of a long flexible stem rooted to the sea-bed.

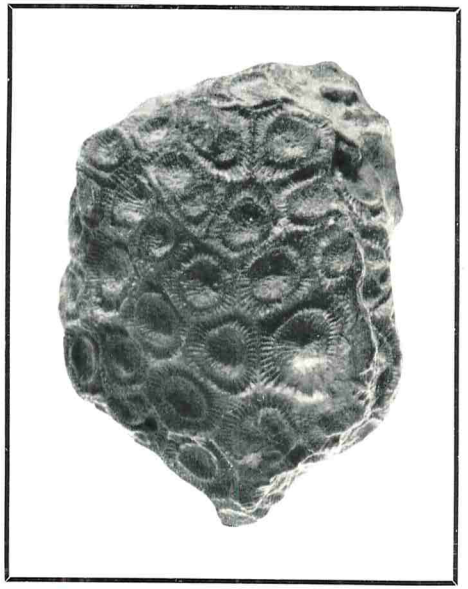
Brachiopods are bivalved shell-fish of which only a few species are still living. Once very abundant, they have been largely superseded by the more adaptable Molluscs.

Molluscs became increasingly important as the Lower Palaeozoic era progressed. One group, the *Cephalopods*, were distant ancestors of the octopus and squids but differed in possessing long conical shells to protect their soft bodies. They were giants of their day with shells up to 15 feet in length.

Above: An early Cephalopod *Orthoceras* (Model). Below left: Solitary coral. Below right: Colonial coral.







The Devonian fish *Holoptychius* as a model and as fossil remains.

The Age of Fish

The first fish date from the Ordovician period, but these appear to have been freshwater forms which lived in rivers or small lakes. Consequently they were seldom preserved in fossil form and little is known of them. Not till the Devonian period, 400 million years ago, did fish begin to inhabit the seas but so numerous did they then become that the period is often referred to as 'The Age of Fish'.

Though some of the Devonian fish were primitive jawless types (Agnathids), the first of the jawed fish also appeared at this time. Their bodies were covered with massive plates, very much more cumbersome than the flexible scales of modern fish, which may have served to protect them from attack by Eurypterids – giant sea-scorpions which sometimes reached 12 feet in length.

Throughout Devonian times a hot arid climate gave rise to desert conditions over the British area. During the long dry seasons the inland lakes and coastal estuaries inhabited by the fish would shrink in size and sometimes dry up altogether. To increase their chances of survival under such conditions, some fish developed primitive lungs into which they could gulp air as the waters grew foul. These were the first 'Lung-fish' whose descendants, remarkably little changed, are still to be found in Africa, South America and Australia.

The conquest of the land

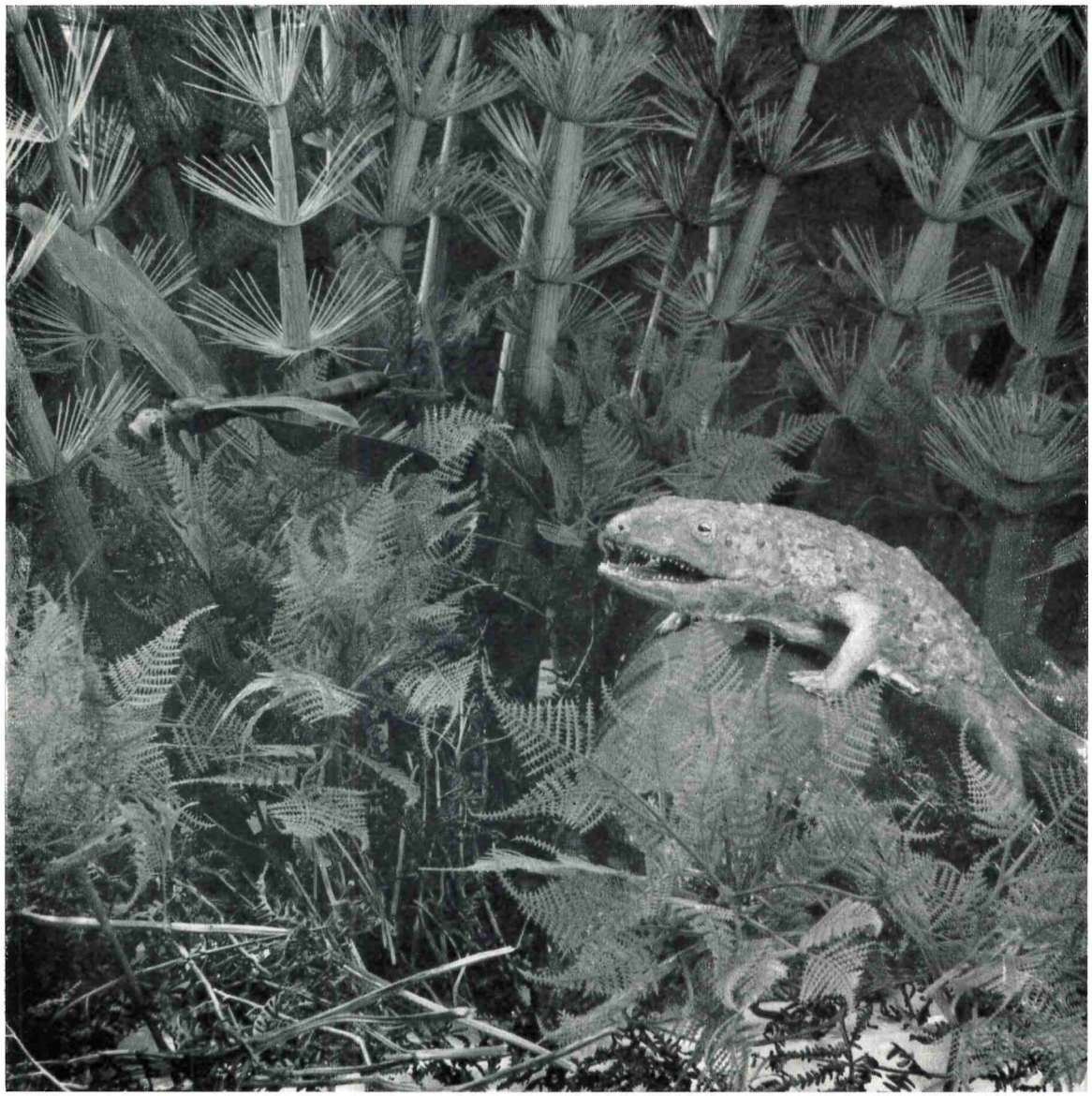
For hundreds of millions of years, while the seas teemed with life, the land areas of the earth had remained barren and uninhabited. The invasion of the land, when it eventually came, was prolonged and unobtrusive rather than sudden and spectacular.

Sea-weeds began to grow on the rocks of the shore in Silurian times more than 400 million years ago. During the succeeding Devonian period land plants spread and flourished, while scorpions, spiders and wingless insects became the first animals to colonise the newly-vegetated continents.

In Devonian times too fish with primitive lungs crawled out onto the land on lobed fins which were to evolve into limbs. These were the first of the Amphibians, breathing air but still compelled to return to the water to lay their eggs. Not until the Carboniferous period did a new group of animals evolve which could lay their eggs on land. These were the Reptiles and with their appearance the last links with the sea were broken and the conquest of the land was complete.

A Carboniferous Seed-fern.

Reconstruction of Coal Forest showing *Meganeura* and an early amphibian.



The coal forests

By the Upper Carboniferous period, 300 million years ago, animals and plants were well established on the land. In Europe and North America the climate was tropical and swamp-forests grew on low-lying deltas which were periodically submerged by the sea. The masses of rotting vegetation which accumulated in the swamp waters were, in the course of millions of years, converted to the coal seams of the present day.

The plant life of the coal forests consisted mainly of ferns, horsetails and evergreen trees, the most impressive being the Lycopods or 'Scale-Trees' which rose 100 feet or more in height. Giant horsetails grew in dense bamboo-like groves alongside the rivers and swamps. 40 feet tall, they were very different from the diminutive forms familiar today. The ferns resembled modern bracken fronds but reproduced by means of seeds, not spores, and are therefore classified as Seed-ferns (Pteridosperms). True flowering plants, much more recent in origin, were totally absent from the coal forests.

The animal life of the late Carboniferous included the first winged insects, among them the giant dragon-fly *Meganeura* with a wing-span of 29 inches.

Fish were common in the swampy pools of the coal forests and the amphibians reached their peak during this and the succeeding Permian period. Their reign was short-lived, however, and in the topmost beds of the Carboniferous succession are found the skeletons of the first of the reptiles destined to supplant them. With the overthrow of the amphibians by their reptile descendants 225 million years ago, the Palaeozoic era came to an end.

The Dinosaurs

By the beginning of the Triassic period the giant amphibians of the late Palaeozoic had died out and the supremacy of the reptiles was unchallenged. The 150 million years that followed comprised the Mesozoic era which has fittingly been termed 'The Age of Reptiles'.

Mesozoic reptiles were of many types and some, such as the turtles and crocodiles, were very like those of the present day. Others have long been extinct – the flying Pterosaurs for example, or the Dinosaurs, many of which attained giant size.

Dinosaurs are divided into two groups which differ in details of their anatomy. The Saurischian Dinosaurs have a typically reptilian pelvis, whereas that of the Ornithischian Dinosaurs is of the type found in birds. These two major groups are then sub-divided into six families:

SAURISCHIANS	THEROPODS predatory meat-eating dinosaurs SAUROPODS giant swamp-dwelling dinosaurs
ORNITHISCHIANS	ORNITHOPODS duck-billed dinosaurs STEGOSAURS plated dinosaurs ANKYLOSAURS armoured dinosaurs CERATOPSIANS horned dinosaurs

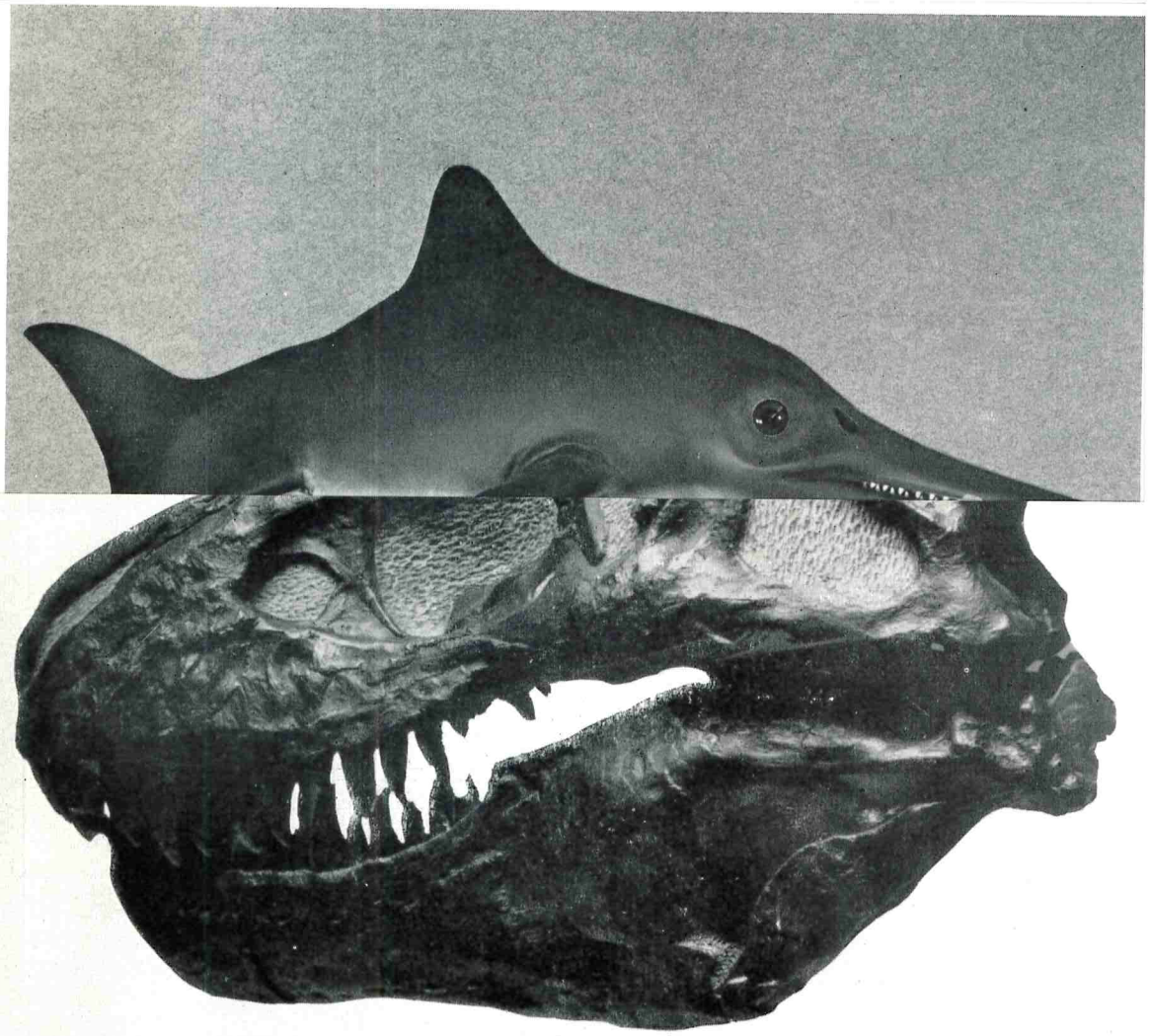
The lengths and estimated weights of a number of dinosaurs are listed on the next page, together with comparative figures for living animals.

It will be seen that, for all their great size, many dinosaurs were comparable in weight to a large elephant. The most notable exceptions were the giant Sauropods which probably spent most of their lives wading in shallow lakes where the water would buoy up their massive bodies.

It is interesting to note, however, that even the greatest of these giants – the immense *Brachiosaurus* – cannot compete either in size or weight with the present-day Blue Whale which is by far the largest animal in the whole of the earth's history.

Skull of *Triceratops*.

Skull of *Tyrannosaurus*.



Some facts and figures

DINOSAURS	Length	Estimated Weight*
COELOPHYSIS An early dinosaur	8 feet	40–50 lbs.
PROTOCERATOPS A Ceratopsian	6	400
STEGOSAURUS A Stegosaur	20	$1\frac{3}{4}$ tons
ALLOSAURUS A Theropod	30	2
ANATOSAURUS An Ornithopod	40	3
PALAEOSCINCUS An Ankylosaur	15	$3\frac{1}{2}$
IGUANODON An Ornithopod	30	$4\frac{1}{2}$
TYRANNOSAURUS The largest Theropod	50	7
TRICERATOPS A Ceratopsian	24	$8\frac{1}{4}$
DIPLODOCUS A Sauropod	85	$10\frac{1}{2}$
BRONTOSAURUS A Sauropod	70	30
BRACHIOSAURUS The largest Sauropod	82	75
LIVING ANIMALS		
INDIAN ELEPHANT	10	$3\frac{1}{2}$
AFRICAN ELEPHANT	11	5
BLUE WHALE	100	120

*Weights of Dinosaurs after Edwin H. Colbert (1962): American Museum of Natural History. Novitates No. 2076

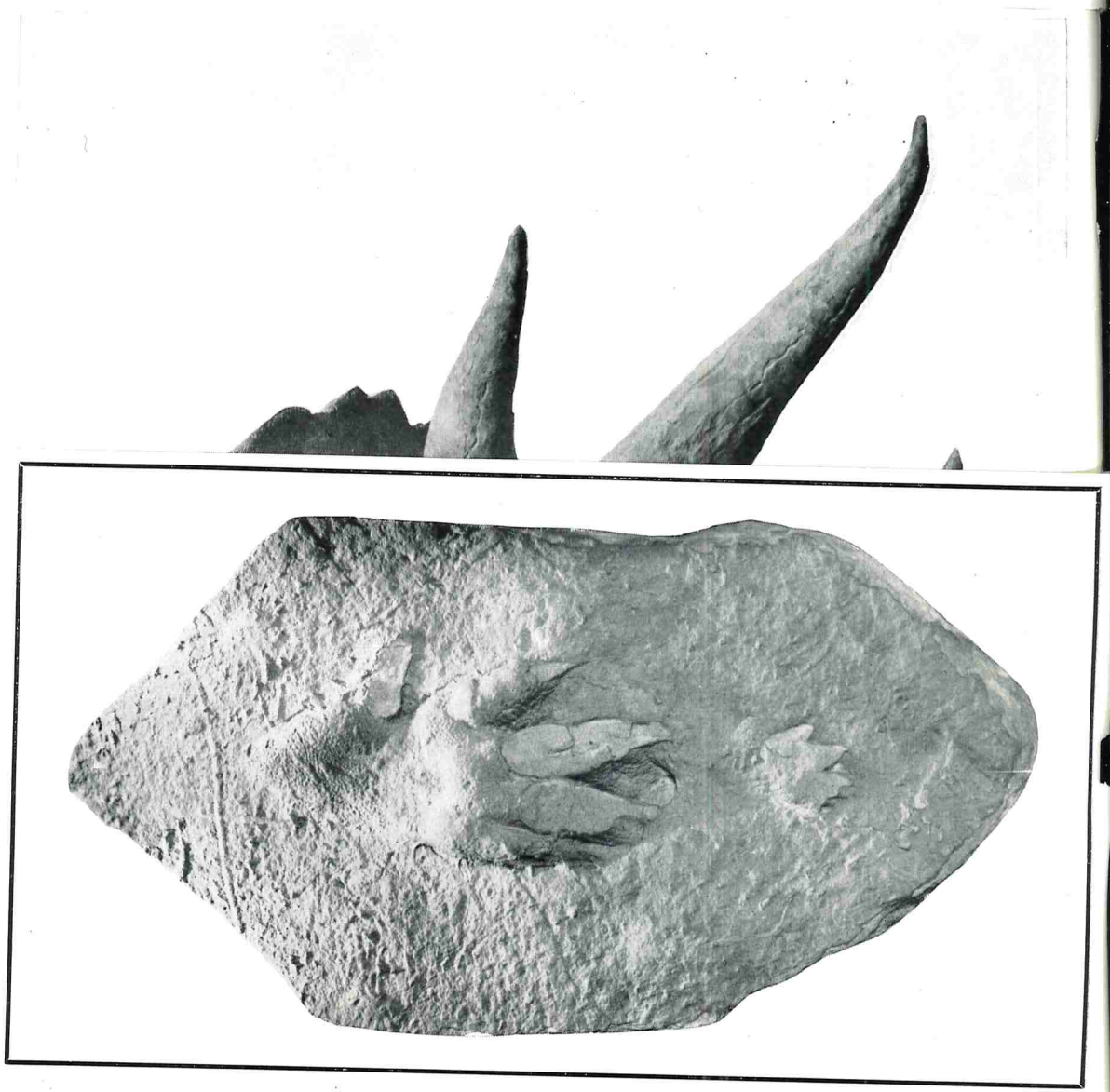
Chirotherium

The rocks on which Liverpool now stands are a thick series of desert sandstones formed during the Triassic period about 200 million years ago.

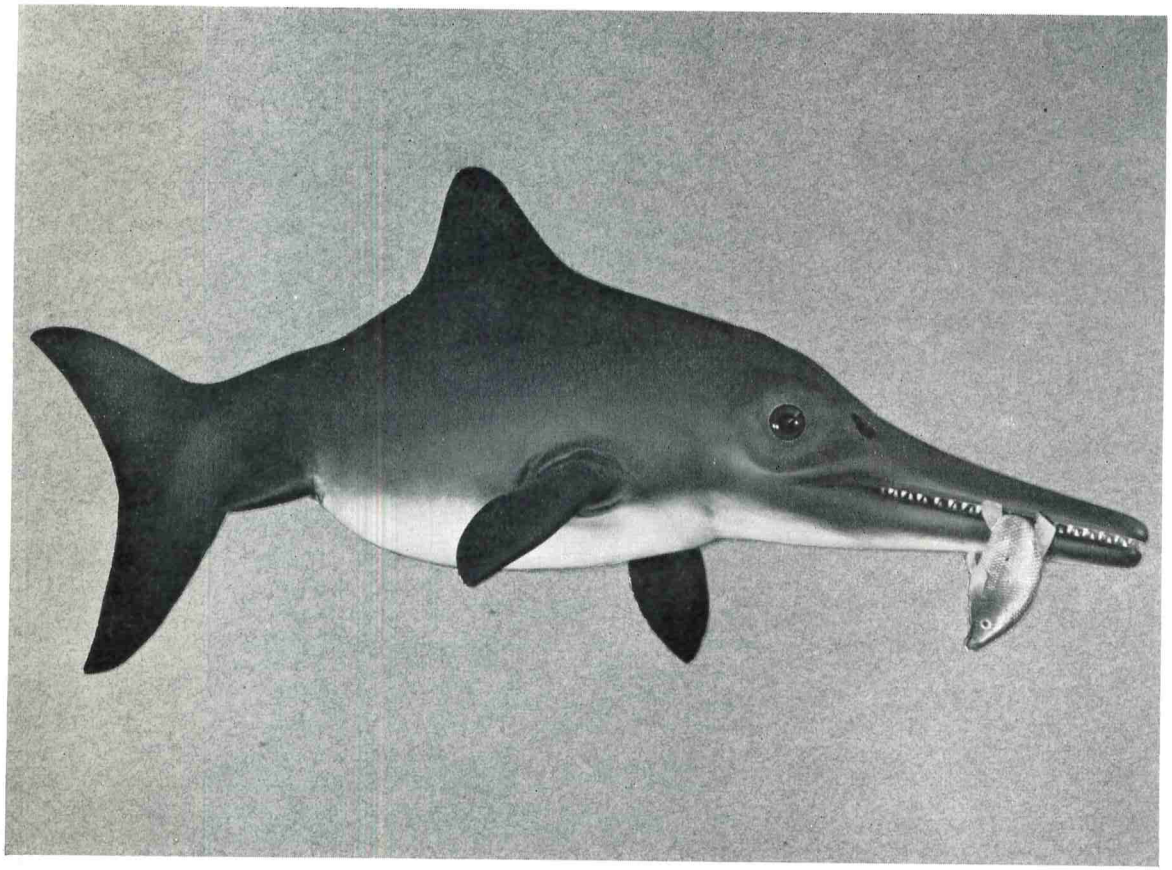
Around the temporary lakes which formed on the desert flats after the occasional rains were left the footprints of one of the early dinosaurs, *Chirotherium* – the 'Hand Animal'. The photograph shows a slab of Keuper Sandstone from the famous Footprint Bed of Storeton Quarry, near Birkenhead. On it can be seen the hand-like imprint of the hind foot together with the much smaller print of the fore-foot.

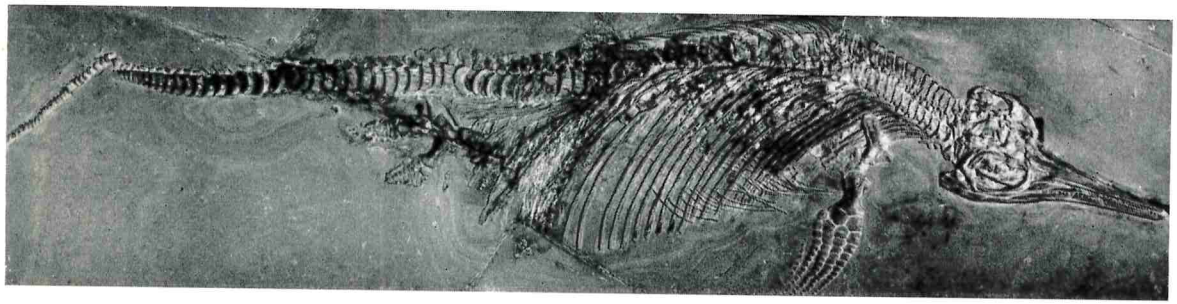
Though such prints are quite common at Storeton and in Germany, no bones or other traces of the dinosaur itself have been found in association with them. By some freak of preservation all material remains have vanished from the rocks and only the footprints survive as proof that *Chirotherium* ever existed.

Chirotherium footprints.



Above: Ichthyosaur (Model). Below: Fossil Ichthyosaur skeleton.





The return to the sea

The reptiles, laying their eggs on land, had become completely independent of the waters to which their amphibian ancestors returned to breed. In consequence their numbers increased to such an extent that the Mesozoic land-masses were in danger of becoming over-populated. It was inevitable, therefore, that some reptiles should turn back to the sea which offered unlimited space and an abundant food supply in the form of fish.

By the early Jurassic period (180 million years ago) the sea-going reptiles included turtles as well as the now extinct Ichthyosaurs ('Fish Lizards') and Plesiosaurs. These remained air-breathing animals but in all other respects had reverted to an aquatic way of life.

The Ichthyosaurs in particular were beautifully adapted to life in the sea with streamlined bodies and powerful tails to propel themselves through the water. Their limbs had degenerated into small paddles which would have been useless on land, but underwater served to steer the animal as fins do a fish.

Despite this high degree of adaption, the Ichthyosaurs and Plesiosaurs were extinct by the close of the Cretaceous period. On land the dinosaurs also died out, to be replaced by the mammals in the succeeding Caenozoic era. As the mammals spread and flourished, competition on the land again forced some forms (the whales and dolphins) to take to the seas. The physical resemblance between dolphins and Ichthyosaurs is strikingly close – the mammals having adapted themselves to their new environment exactly as did their reptile predecessors.

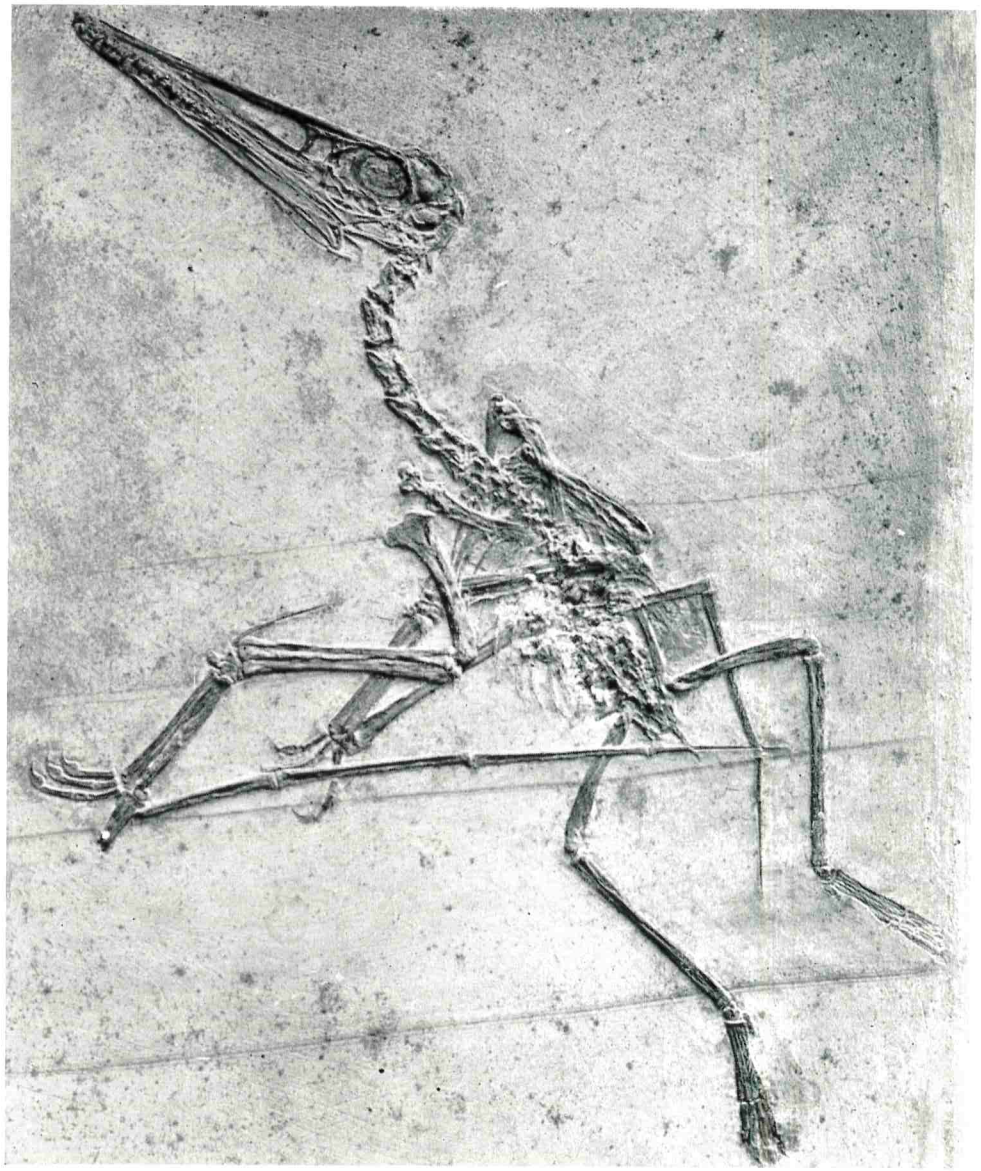
The miniature dragons

The flying reptiles of the Jurassic and Cretaceous periods, usually known as 'Pterodactyls' are more correctly referred to as the Pterosaurs. The popular name is misleading since, strictly speaking, it implies one particular kind of Pterosaur (in the same way that 'Pigeons' implies one particular kind of bird).

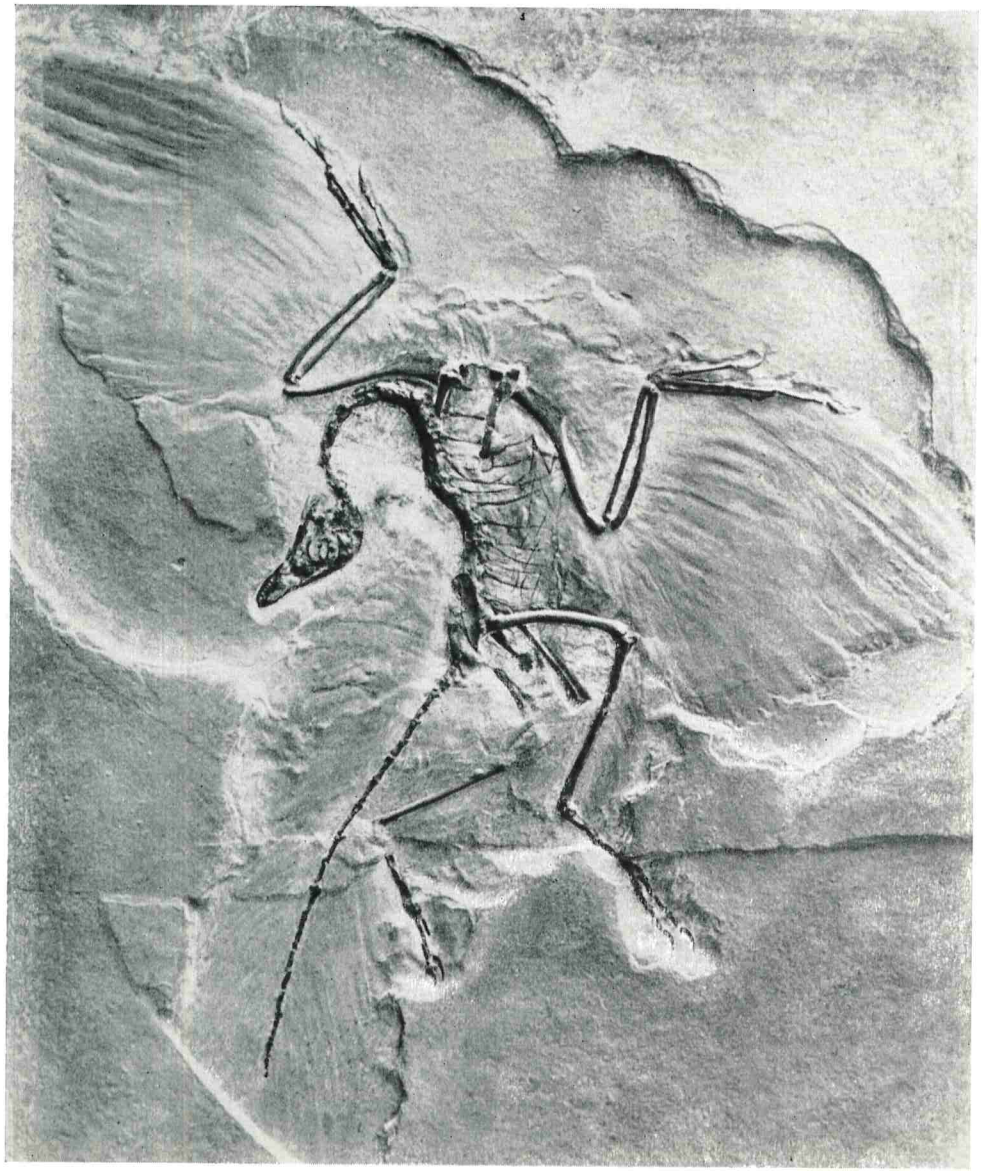
The wings of the Pterosaurs were more like those of bats than birds, and consisted of a leathery membrane supported by one greatly elongated claw. The long beak-like jaws were plentifully equipped with teeth and all in all they must have looked very like dragons in miniature.

For almost all the Pterosaurs were very small: some were no bigger than sparrows and *Pterodactylus* itself was only the size of a starling. A notable exception was the mighty *Pteranodon* from the Upper Cretaceous of Kansas which had a wing-span of 26 feet.

Pterodactylus – a flying reptile.



Archaeopteryx – the first bird.



Archaeopteryx

A strange fossil skeleton found in Bavaria in 1861 proved that the Pterosaurs were not alone in developing powers of flight. This fossil, which was named *Archaeopteryx*, had clawed wings, toothed jaws and a long bony tail. All these features were also characteristic of the Pterosaurs and it would undoubtedly have been classed as a new kind of flying reptile but for one vital piece of evidence. The fine mud in which it lay had preserved clear impressions of feathers on the wings and tail. These proved beyond all doubt that, despite its reptile-like features, the skeleton was that of one of the first birds. It dated from the Upper Jurassic period 140 million years ago.

The birds had one great advantage over the reptiles from which they had evolved. Warm-blooded, and with bodies insulated by down and feathers, they were much better equipped to withstand the cold. Thus birds were not confined to tropical latitudes and, perhaps for this reason, survived the climatic changes which brought about the extinction of the Pterosaurs at the close of the Cretaceous period.

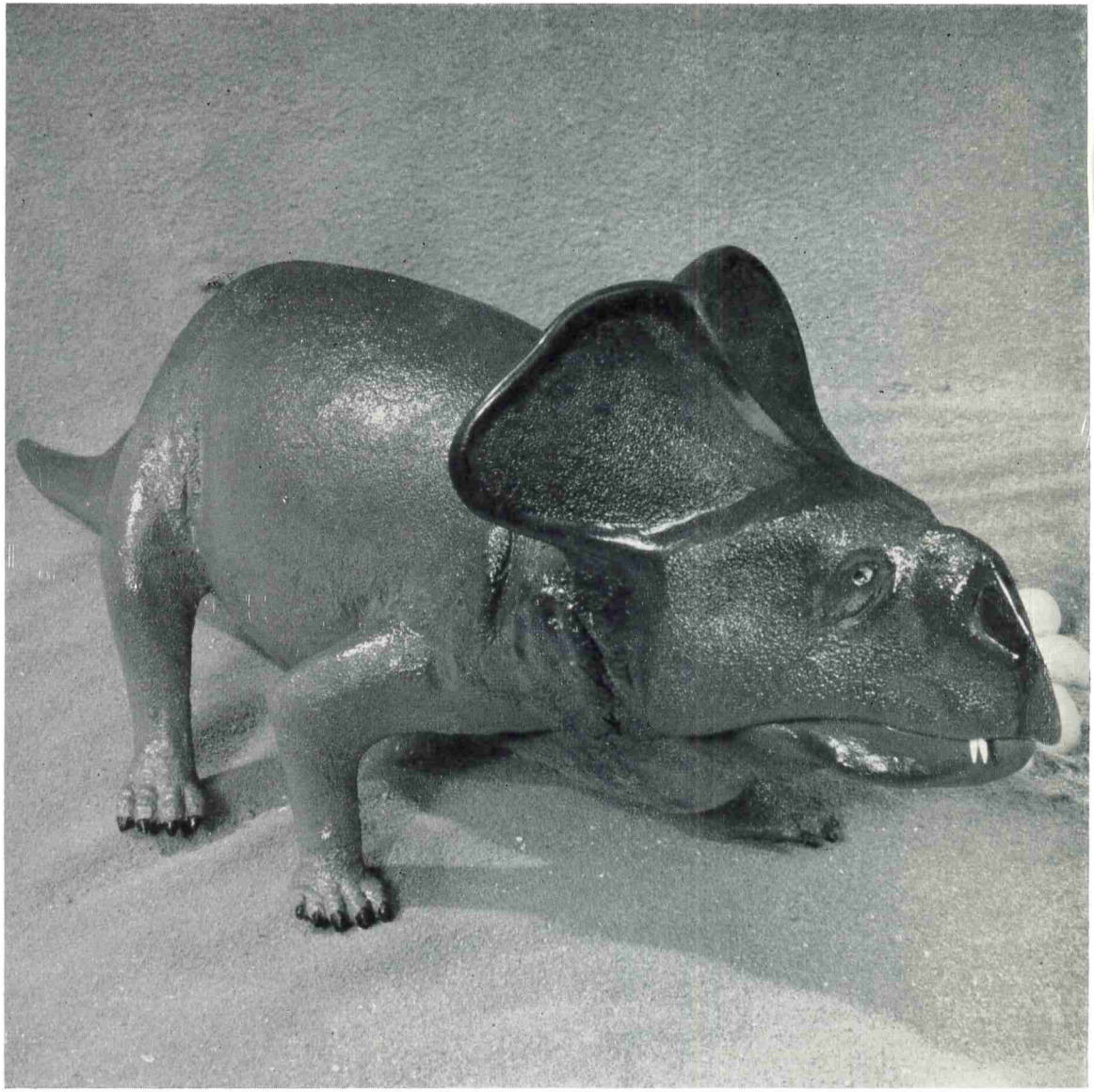
Protoceratops

In 1922, and again in 1925, the American Museum of Natural History sent scientific expeditions to the Gobi Desert of Outer Mongolia. Their most exciting finds were a number of nests of dinosaur eggs preserved in desert sandstones dating from the Upper Cretaceous period, 95 million years ago. In the same beds were more than a hundred skeletons of the dinosaur *Protoceratops* ranging from newly hatched to fully mature specimens. It seemed probable therefore that the nests were those of the same dinosaur and the discovery of an unhatched embryo in one of the eggs proved this beyond all doubt.

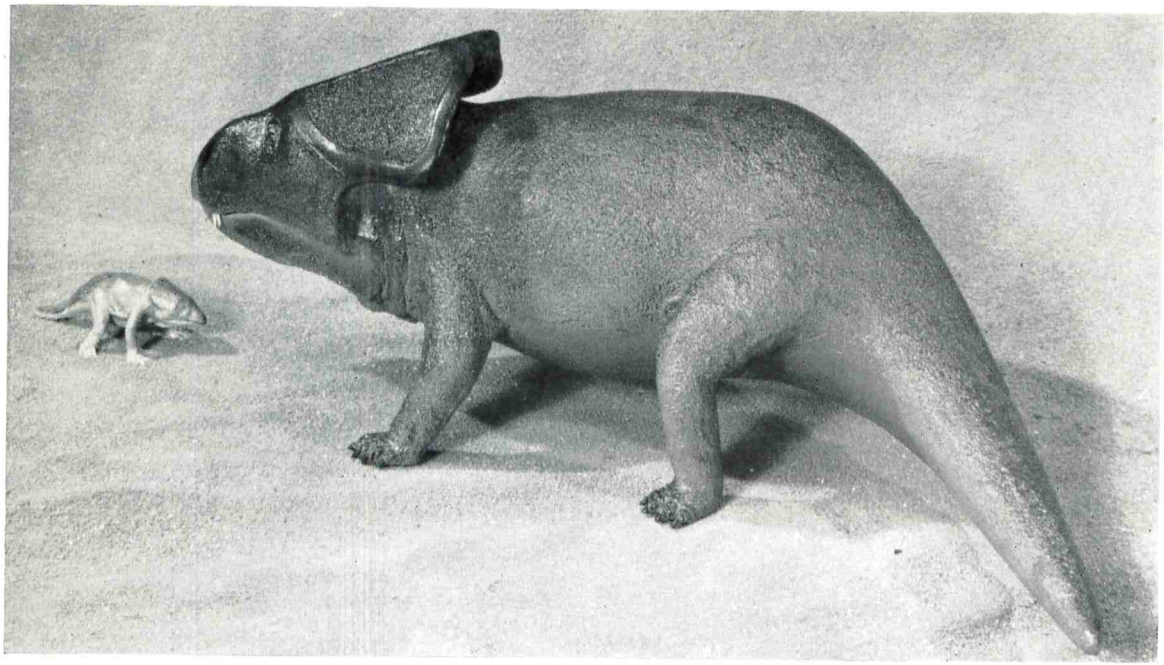
Protoceratops was one of the smaller dinosaurs reaching 5-6 feet in length when fully grown. The adult skeletons were of two types which differed in size and in the shape of their skulls. These presumably correspond to the two sexes and it seems probable that the larger skeletons with heavily armoured skulls are those of the male dinosaurs.

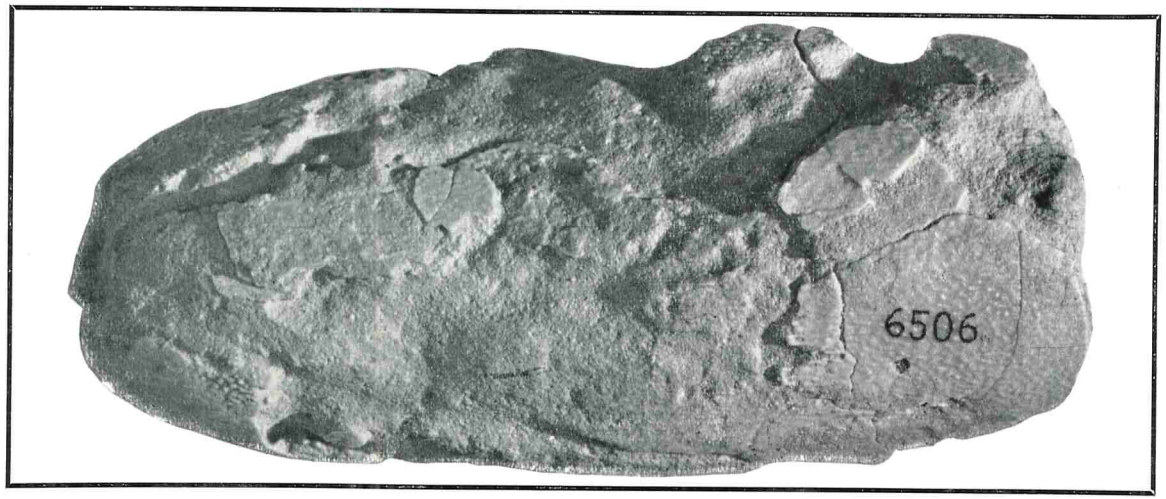
Like modern crocodiles the females laid their eggs in a hollow in the sand and left them for the heat of the sun to hatch. While some of the fossilised eggs were preserved intact, many had been broken and infilled with sand so that only fragments of the shell can be seen.

Protoceratops – adult male (Model).



Above: *Protoceratops* – baby and adult female (Models). Below: Egg of *Protoceratops*.





The disappearance of the dinosaurs

Seventy million years ago at the end of the Mesozoic era the dinosaurs and many allied reptiles became totally extinct. The reasons for this mass extinction are not readily apparent but geographical changes, together with a cooler climate, may have been mainly responsible. There is some evidence of a general lowering of temperature at the close of the Cretaceous period and this would obviously affect the reptiles much more than it would warm-blooded animals such as the mammals and birds.

In addition, new forms of vegetation had appeared in Cretaceous times, including deciduous trees which shed their leaves in winter. This, it has been suggested, starved first the browsing dinosaurs and hence the carnivores which preyed on them.

Competition from the more adaptable birds may account for the disappearance of the flying Pterosaurs. It is, however, difficult to understand why, among sea-going reptiles, the Ichthyosaurs and Plesiosaurs died out whereas the ungainly turtles have survived till the present day.

The simultaneous extinction of so many apparently successful and well-adapted animals is one of the strangest features of the earth's history. With the disappearance of the giant reptiles dominance passed to a new group – the Mammals.

The rise of the mammals

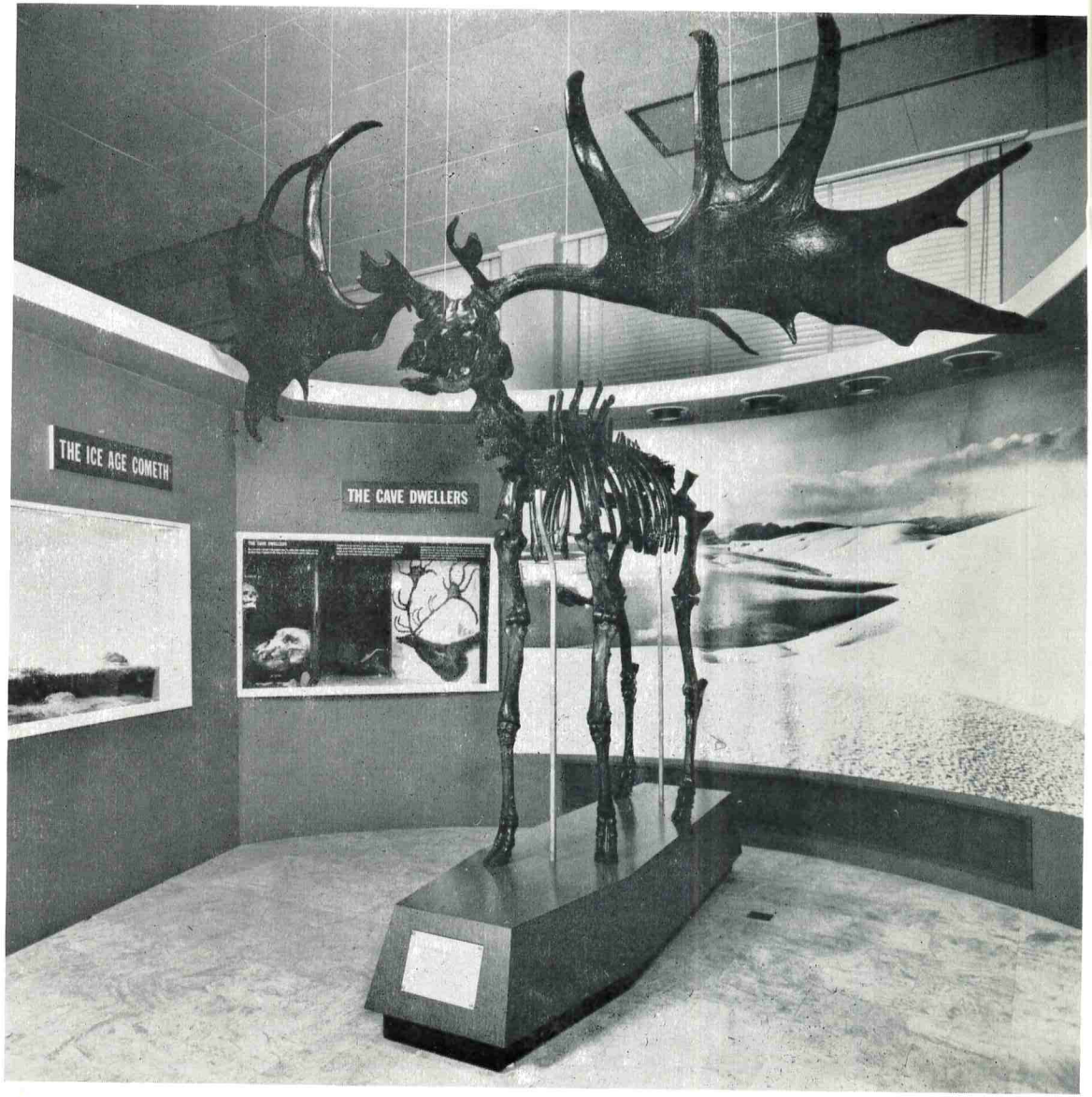
Mammals are warm-blooded animals whose body temperature is maintained at a constant level by sweat-glands and an insulating coat of hair or fur. They give birth to live young which are then suckled by the mother.

The first mammals date back to the Triassic period but throughout the Mesozoic they remained small in size and few in numbers. Though dwarfed and outnumbered by the giant reptiles of the era, they proved much more adaptable so that when the dinosaurs became extinct it was the mammals, rather than the surviving reptile groups, which took their place.

The 70 million years from the close of the Mesozoic till the present day are classed as the Caenozoic era, or more simply as the Age of Mammals. The mammals reached their peak in the Miocene period and since then have been in decline. During the last 2 million years in particular the climatic rigours of the Ice Age led to the dying out of many species.

The Giant Deer, *Megaceros giganteus*, with its impressive 11-foot span of antler, was one of the many giant forms characteristic of the Pleistocene period. Inhabiting the barren tundra plains which bordered the ice-sheets, it became extinct about 5,000 B.C. as dense coniferous forests spread northward across Europe in the wake of the retreating ice.

Skeleton of Giant Deer.



Mammoth (Model).

The Ice Age

The Pleistocene period of the last 2 million years is conveniently, if over-simply, described as 'The Ice Age'. It in fact consisted of, not one, but a whole series of ice ages during which Europe and North America were covered by thick ice sheets. Alternating with the glacial epochs were warmer interludes when ice-caps disappeared completely or were confined to the polar regions.

These inter-glacial periods were often so warm that Europe became the home of many animals now found only in the Tropics. With the re-advance of the ice-sheets such animals would attempt to migrate south to warmer latitudes. If, however, their way of retreat was cut off by the sea or by high mountain chains such as the Alps, they were forced to adapt themselves to life under arctic conditions or die out altogether.

Among the animals which survived the worst rigours of the Ice Age were the Mammoths. Members of the elephant family, they were protected from the cold by shaggy coats of hair covering the whole of their bodies. Characteristic of the late Pleistocene period, they died out with the final retreat of the ice sheets about 8,000 B.C. Where arctic conditions still persist—in Northern Siberia for example—frozen mammoth carcasses in a perfect state of preservation have occasionally been found.

The cave dwellers

One of the new mammals to appear during the Ice Age was Man himself. The earliest known human remains are from Pleistocene beds found in the Olduvai Gorge of Tanganyika. Radioactive (Potassium/Argon) dating suggests an age of $1\frac{3}{4}$ million years for these beds.

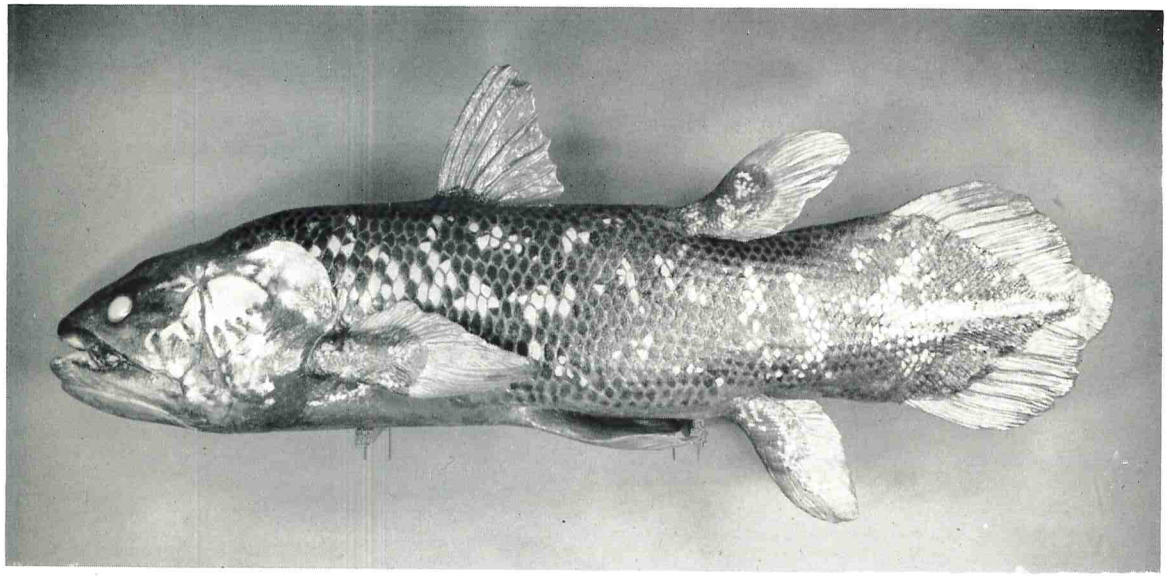
During the glacial episodes of the Pleistocene, man relied on caves to provide shelter from the extreme cold. To obtain possession he would often have to drive out or kill other cave-dwelling animals of the period. These included Cave Lions, Cave Hyaenas and the giant Cave Bears, all of which are now extinct. Their fossil remains, together with the gnawed bones of the animals on which they preyed, are preserved in the deposits which accumulated on the cave floors. Human remains may also be found, and from such evidence it is often possible to determine the sequence of inhabitants during the various glacial episodes.

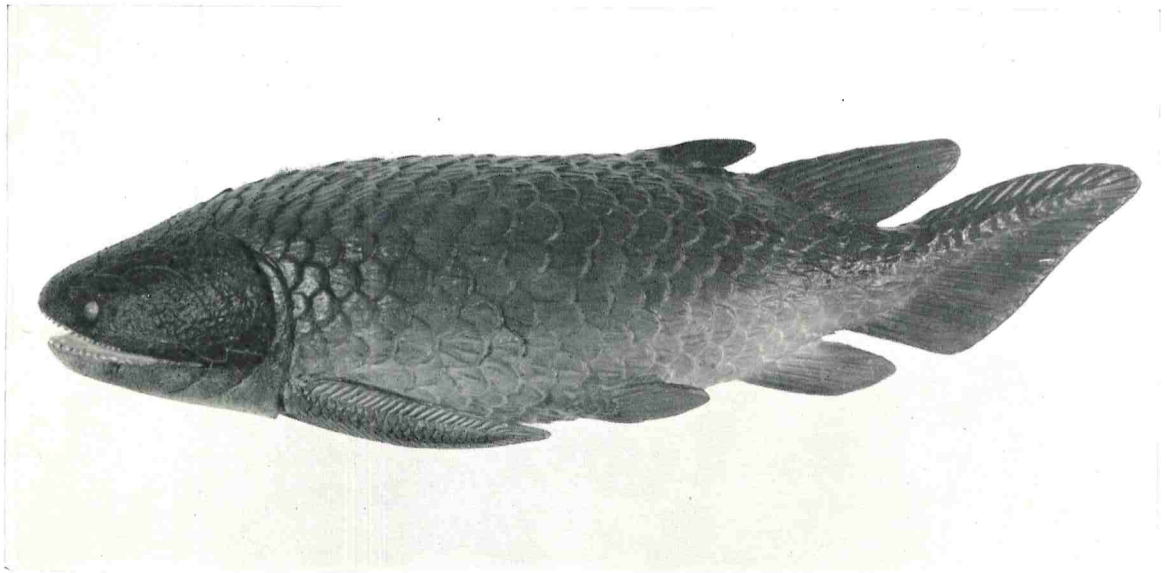
Apart from these fossils, and the flint axes used as weapons, the caves also provide evidence of Palaeolithic man's increasing artistic skill. Cave-paintings were usually of the animals hunted for food and horses, deer and bisons were favourite subjects. The fact that many paintings are found in the darkest, least accessible parts of the caves suggests that they were not produced merely as decorative murals but were probably associated with ritual magic to ensure successful hunting.

Throughout his brief life-span, and especially in the 10,000 years that have elapsed since the last retreat of the ice-sheets, man has increasingly dominated the natural world. He has been uniquely successful, first in adapting himself to his environment, and later in shaping that environment to meet his particular needs. It is unfortunate, though perhaps inevitable, that these achievements have only been possible at the expense of many other species of animal.

Skull of Cro-Magnon Man (Cast).

Above: Coelacanth. Below: *Holoptychius* (Model).





The key to the present

Man's ancestry and early history are, strictly speaking, the concern of the anthropologist and archaeologist rather than the geologist. Similarly, although the study of the animals and plants of the past falls within the scope of Geology, their present day descendants are the province of the zoologist and botanist.

This interrelationship of Geology with the biological sciences is emphasised by 'Living Fossils' – surviving species of groups of animals important in the past but now on the verge of extinction. One such is the Tuatara, a small lizard-like reptile found only on waterless islands off the coasts of New Zealand. This is noteworthy as the sole present day representative of the Rhynchocephalians – a group of 'beak-headed' reptiles which were contemporaries of the Dinosaurs.

Occasionally such chance survivors from the past can throw valuable light on evolutionary history. Thus the Platypus and Spiny Anteater of Australia are the only mammals to lay eggs rather than give birth to live young. Egg-laying is, of course, one of the characteristics of the reptiles from which the mammals originally evolved. It is thus reasonable to assume that these two species have preserved a primitive trait characteristic of the earliest mammals but superseded as more advanced forms developed.

Best known of all Living Fossils is the Coelacanth which, until one was caught off Madagascar in 1938, was believed to have been extinct since the Cretaceous period. It was lobe-finned fish of this type which gave rise to the first amphibians, and comparison of the Coelacanth with the Devonian fish *Holoptychius* emphasises how little this group has changed over a period of 350 million years.

Such animals, and indeed all the forms of life which now exist, are integral parts of an evolutionary chain stretching back for hundreds of millions of years to the dawn of life itself.

Geology was first made comprehensible by Hutton's maxim:
'The present is the key to the past.'
In the light of our knowledge today this could fittingly be rephrased:
'The past is the key to the present.'

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